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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Erasible and Reprintable Paper and Ink, and Printing and Erasing System Using Such Paper and Ink

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(30) (JP) 279669/1990 1990/10/18

(57) 17 Claims

Canada

ABSTRACT OF THE DISCLOSURE

A paper is made from materials interchangeable into non-visible/visible conditions. In an alternative, ink is made from materials interchangeable into non-visible/visible conditions. A printing unit prints the paper by making the materials of the paper to be changed from non-visible condition to visible condition. In an alternative, a printing unit prints the paper by jetting the ink of the visible condition onto the paper. An erasing unit erases the pattern printed on the paper by making the materials of the paper or ink to be changed from visible condition to non-visible condition.

SPECIFICATION

ERASIBLE AND REPRINTABLE PAPER AND INK, AND PRINTING AND ERASING SYSTEM USING SUCH PAPER AND INK

BACKGROUND OF THE INVENTION

This invention relates to erasible and reprintable paper, ink for printing, and printing and erasing system using such paper and ink, and more particularly it relates to printing and/or erasing systems capable of reusing papers or forms by using such paper or ink.

Recently, the forest resources on the earth are approaching a serious crisis and the exhaustion of forest resources is now a growing international issue. With the development of vaious industries, the volume of paper and paper products consumed at households, institutions and corporations is far from decreasing, and shows a rapidly upward tendency every year. In such circumstance, although the need for recycling of used paper and paper products is loudly cried for, it encounters big obstacles since it requires assorting works and special treatments for such paper as used for duplicating machines and facsimile machines because the paper contains some chemical materials.

Meanwhile, viewed from the utilization of the paper used for the duplicating and facsimile machines, however, in most cases, the printed papers are stored in files for some time, and then disposed of when desired. The disposal of such paper requires much time and expensive costs involved because it requires to keep secrecy of written contents in the paper.

As such, the development of industries and the upgraded life of people cause to people consider that the paper is

disposable artcles. The exhaustion of forest resources is going on. The increase in carbon dioxide in the atmosphere has brought a significant, so called, greenhouse effect to the earth.

In Japan where the volume of paper is consumed the most or second within advanced countries, the reuse of used paper is falling behind, which brings about waste problem which in turn involves the daily life of people.

Viewed the aforementioned reuse of paper from prior art point, the reuse ratio of used paper is not going upward due to costs involved. Genarally, used papers are classified at offices and households and then collected by waste collectors for reuse. In the procedure of reuse of paper, there are lots of works to be done and transportation costs involved, in addition to the costs required to treat inks and chemical materials contained in special paper. In this manner, the reuse of used paper does not pay at present. In addition to the above disadvantages, the qaulity of reproduced paper is significantly bad as compared with that of fresh paper, which is another factor in delay in population of the reproduced paper.

Preservation of forest resouces and protection of environment of the earth is very important to us. For this very important theme, the reuse of used paper made by corporations, institutions, and households must be advanced to minimize the consumption of forest resources. This will be one of factors to provide great effects that can be easily carried out in our daily life.

The existing reproduction technology for used paper requires much burden for users in terms of higher costs incurred as compared with that of fresh paper in addition to disadvantages of the inferior quality of the reproduced

paper, which is a big obstacle for reuse of paper not to be widely spreaded among the general public. Therefore, the reproduction technology using prior art requires much labor forces and facilities, which raises the costs of reproduced paper. Thus, there is no advantage from economical viewpoints. In the system of prior art, the primary problem is that classification of various kinds of used papers such as business forms discharged from office automation equipment or plain paper must be made by users. Secondly, it requires personnel expense and transportation costs for collection of used paper, and the large storage space to store collected paper before reproduction process is started. In such situation, therefore, it is difficult to locate the area for a reproduction plant in the outskirts of a big city. Furthermore, such a reproduction plant which may use great amount of chemical materials can bring about environment pollution in that area.

SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to provide an erasible and reprintable forms or papers and ink for use therewith as well as recording and erasing systems using the above mentioned paper or ink which is capable of eliminating the above mentioned disadvantages involved in prior art.

In order to accomplish the object of the invention, there is provided a paper made from materials interchangeable into non-visible/visible conditions whereby a pattern printed on the paper can be erased to reuse the paper repeatedly.

There is also provided a system for printing and/or erasing a paper made from materials reversibly interchangeable into non-visible/visible conditions which comprises erasing means for changing the pattern printed on the paper from

visible condition to non-visible condition and printing means for changing the pattern printed on the paper from non-visible condition to visible condition.

There is also provided a printing system for a paper made from materials reversibly interchangeable into non-visible/visible conditions which comprises a paper feeding mechanism for feeding a paper through a printing position, a laser source for generating laser beams, and scanning means for scannig the laser beams impinged on the paper fed through the printing position.

There is also provided an erasing system for a paper made from materials reversibly interchangeable into non-visible/visible condition which comprises a paper feeding mechanism for feeding a paper through an erasing position, a laser source for generating laser beams, and scanning means for scannig the erasing laser beams impinged on the paper fed through the erasing position.

There is also provied an ink made from materials reversibly interchangeable into non-visible/visible conditions.

There is also provided a system for printing and/or erasing an ink made from materials reversibly interchangeable into non-visible/visible conditions which comprises erasing means for changing the pattern printed on the paper from visible condition to non-visible condition and printing means for changing the pattern printed on the paper from non-visible condition to visible condition.

There is also provided a system for printing and/or erasing an ink made from materials reversibly interchangeable into non-visible/visible conditions which comprises ink

jetting means for jetting an ink to the paper and control means for controlling the jetting of ink in accordance with the patterns to be printed on the paper.

There is also provided an erasing system for an ink made from materials reversibly interchangeable into non-visible/visible condition which comprises a paper feeding mechanism for feeding through an erasing position a paper on which ink is applied to, a laser source for generating a laser beams, and scanning means for scannig the erasing laser beams impinged on the paper fed through the erasing position.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be now described in detail with reference to the preferred embodiments illustrated in the accompanying drawings in which:

Fig. 1 is a perspective view of paper made from the materials reversibly interchangeable into non-visible/visible conditions with the parts broken away.

Fig. 2 is a top plan view of an overall configuration of a printing unit using the paper.

Fig. 3 is a perspective view of a preferred embodiment of the printing unit.

Fig. 4 is a perspective view of a preferred embodiment of an erasing unit.

Fig. 5 is a block circuit diagram of the printing unit.

Fig. 6 is a block circuit diagram of the erasing unit.

Fig. 7 is a cross-sectional view of the printing unit using ink made from the materials reversibly interchagable into non-visible/visible conditions.

Fig. 8 is a top plan view of an overall configuration of another printing unit.

Fig. 9 is a perspective view of an embodiment of another erasing unit.

Fig. 10 is a block circuit diagram of the erasing unit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

To begin with, the features of papers or forms in accordance with the invention will be described. The materials to be mixed with or applied on paper are those reversibly interchangeable into non-visible/visible conditions. That is, the materials are changed from non-visible condition into visible condition and reversely changed from visible condition into non-visible condition. Those may be a single material or composite materials. Those materials includes a phase-change material its refraction index of which reversibly varies in accordance with application of heat thereto (for example, compound material which contains either one of chemical compounds such as chalcoganate compound, antimony compound and germanium compound), and a photochromic material (spiro-pirane based material and fulgide based material) its absorbance (achromatic-coloring) of which reversibly varies by application of the laser beams with different wave-lengths.

The printing paper used in the present system includes paper for office use such as paper for duplicating machines and printers, and reporting paper as well as slips for office use and the like.

The provisions of the material to the paper can be made by application of the material onto the paper, the mixing of the material and the paper material or vaporization of material onto the paper.

Any suitable pattern such as characters, symbols, figures, or bar-codes can be printed on the paper.

Furthermore, means for printing the patterns on the

paper or erasing the patterns printed on the paper includes a thermal head, a laser-print and laser-beams with different wave-length. The method using laser-print requires more expensive devices as compared with that using thermal head. However, it can obtain high resolution printing qaulity because spot diameter of laser-beams can be focused sharply. In addition, durability of the paper and the printing device can be greatly improved since non-touch printing can be carried out in this method.

In erasing operation, erasing time may become longer due to smaller spot in diameter for the beams. Therefore, it is preferred that there are provided two laser-beam systems, one for erasing operation and the other for printing operation, or laser-beams are used for printing operation while a thermal head is used for erasing operation.

In another approach, the system is divided into an erasing section and printing section, and in the erasing section, erasing time can be shortened by enlarging the area on the paper to be swept or making sweeping speed faster.

Preferred embodiments will be now described in detail with reference to the drawings. For convenience of explanation, the following description is directed to a printer for computer in which a laser printer is used in a printing unit and laser sweeping system is used in an erasing unit. With increase in consumption of printing paper used for office automation machines for preparing documents or drawings, laser printer is now widespread. Therefore, combination of the system according to the present invention and such computer system results in great effects.

Referring now to Fig. 1, there is shown a paper 110 which, in this embodiment, is made by microcapsulating spiro

pirane based photochromic material 112 (hydroxy-benzorospirane) into microcapsules of 10 micron in diameter by usual microcapsulating technique, uniformly mixing the microcapsules with the adhesive, and applying the resultant onto plain paper 114. Spiropirane based photochromic material has a property that it varies from achromatic condition to coloring condition when exposed to light of specific wavelength (ultroviolet wavelengh region) and reversibly returns to achromatic condition by heat absorption, that is, when exposed to white light.

Furthermore, in this embodiment, helium-neon (wavelengh: 632.8 nm) is used as a laser for printing operation and argon (wavelengh: 360nm/multi-line) is used as a laser for erasing operation.

In Fig. 2, there is shown a printing unit 2 in combination of a personal computer 1. In this case, patterns such as characters, etc. are transferred from the personal computer 2 to the printing unit 1 in the form of bitmap information.

In Fig. 3, there is shown a configuration of the printing unit 2. The papers 110 made in accordance with the invention are set in printing paper casing 4 (only location shown) as in an ordinary manner. In printing operation, the papers 110 are removed, one at a time, from the paper casing 4 by a removing mechanism 3 and inserted into a printing mechanism. A paper feed mechanism 5 has a function of feeding the removed paper at uniform speed, and feed the paper 110a over a lambda-sita lens 11 at uniform speed..

Laser beams emitted from a helium-neon laser 7 are condensed by a condenser lens 8, refracted at right angles (90 degrees) by a half-mirror 9, and impinged on a light

modulation element 10. A part of incident beams to the half-mirror 9 passes through it and reaches to a laser power sensor 15, which is used to control the power of laser at uniform level. The laser beams are selectively shut and passed through by the light modulation element 10 in response to on/off signals supplied thereto from a control circiut 14. These on/off signals are provided in synchronization with bitmap information received from the personal computer 1. That is, the laser beams are allowed to pass through only when the paper comes to the bit position for printing. The lambda-sita lens has a function of perpendicularly impinging on the paper the laser beams which is reflected from a polygon mirror 12 and swept by rotation thereof by a motor 13. Thus, the laser beams are impinged on the spots on the paper to be printed, and the photochromic material only on the spots comes to coloring and printing is carried out. Reference numeral 16 indicates a signal sensor for syncronization.

In Fig. 4, there is shown an erasing unit which erases pattern printed on the paper. When the printed paper 110b is inserted to cause the printed pattern thereon to be erased, a paper feeding mechnism 18 first transfers the paper over an image scanner 19 and then transfers it over a lambda-sita lens 20. The image scanner 19 reads the pattern printed on the paper, and the read information is stored in a recording device 23 by a control circiut 24 before erasing is carried out. Thus, when storage of information is not necessary, the image scanner 19 and the recording device 23 can be omitted.

The paper is fed to over the lambda-sita lens 20 after the pattern is read by the image scanner 19 and recorded by the recording device 23. At this time, laser beams emitted from argon laser 25 passes through a condenser lens 26, refracted at right angles by a half-mirror 27, and impinged onto a polygon mirror 20a in a similar manner to those of the

aforementioned printing unit. The argon laser beams are impinged from the polygon mirror 20a through the lambda-sita lens 20 perpendicularly on the paper and swept by rotation of the polygon mirror 20a driven by a motor 21. The argon laser beams used for erasing pattern on the paper sweeps the whole surface of the paper, and causes the microcapsulated photochromic material to change into original achromatic condition.

In Fig. 5, there is shown a configuration of the printing unit described with reference to the Fig. 3. This printing unit fundamentally comprises a laser scanning optical system, a paper feeding system and a system control system, and in addition to these, an interface for transmitting and receiving signals between these systems and a host computer. A pattern information is transmitted from the host computer 47 through the interface 46 to a system controller 40 of the system control system. A mechanism control system 44 of the system controller 40 transmits signals to a paper inserting mechanism 30 of the paper feeding system to feed out the first paper to the paper feeding mechanism 32, which corresponds to that indicated at 3 in Fig. 3.

A paper sensor 31 detects the feeding of the paper and informs the system controller 40 that the paper is fed correctly. The paper feeding machanism 32 controls feeding speed using signals from a paper position sensor 33.

A laser control 42 has a function of keeping the output of the helium-neon laser 34, which corresponds to that indicated at 7 in Fig. 3, at specific level, and its output is always detected by a laser power sensor 41, which corr- :ponds to that indicated at 14 in Fig. 3, and controlled by a control loop when fluctuated.

Printing information output is transmitted as switching signals for laser beams through a bitmap signal processing circuit 45 to a light modulation element 35, which correspods to that indicated at 10 in Fig. 3. The laser beams scan or sweep the paper through a lambda-sita lens 38, which corresponds to that indicated at 11 in Fig. 3, by a polygon mirror 37, which corresponds to that indicated at 12 in Fig. 3. At that time, the printing position is adjusted by the signals from a synchronous signal sensor 39, which corresponds to that indicated at 16 in Fig. 3.

In Fig. 6, there is shown a configuration of the erasing unit described with reference to Fig. 4. This erasing unit comprises a paper feeding system, a laser scanning optical system and a system control system, similar to those of the aforementioned printing unit. In the erasing unit, there are provided an image scanner 62, which corresponds to that indicated at 19 in Fig. 4, for reading patterns such sa characters, and a storage device 63, which correspoonds to that indicated at 23 in Fig. 4, for storing the data of the patterns, in place of the interface and the host computer provided in the printing unit.

The paper which has the printed pattern to be erased is first fed over the image scanner 62 by a paper feeding mechanism 50, which corresponds to that indicated at 18 in Fig. 4. At that time, the patterns printed on the paper are read by the image scanner 62 and the infomation thus obtained is stored in the storage device 63. The output of an erasing argon laser 52, which correspods to that indicated at 25 in Fig. 4, is always monitored by a laser power sensor 58, which corresponds to that indicated at 28 in Fig. 4, and controlled to obtain a predetermined output level. The laser beams are condensed by the condenser lens and scans the paper perpendicularly by a polygon mirror 54, which corresponds to

that indicated at 20a in Fig. 4, and a lambda-sita lens 55, which corresponds to that indicated at 20 in Fig. 4. This causes the photochromic material to be reversibly thermally changed into achromatic condition.

Other configurations of the erasing unit are substantialy the same as those of the printing unit, and thus the detailed explanation thereof will be omitted.

The aforementioned embodiments cover the paper made from the materials reversibly interchangeable into non-visible/visible conditions, and the printing and erasing units using the same. Instead of using the aforementioned paper, the present invention also can apply to the ink made from the materials reversibly interchangeable into non-visible/visible conditions and, therefore, embodiments of such an ink and the printing and erasing units using the same will be described.

To start with, outlined explanation of ink will be given. The materials mixed with the ink are those reversibly interchangeable into non-visible/visible conditions, that is, substantially the same materials used in the aforementioned paper.

The pattern and means for erasing the pattern are the same as those of the aforementioned embodiments, and thus the detailed explanation thereof will be omitted.

Preferred embodiments will be now described in detail with reference to the drawings. For convenience of explanation, the following description is directed to a printer for computer in which an ink-jet type printer is used. The aforementioned erasing unit can be also used in this embodiment.

In Fig. 7, there is shown an ink jet head for printing unit using the ink. An impluse-jet system in which the particles of the ink are jetted by applying instantaneous pressure with a piezoelectric element will be shown as an example. The ink 64 which is poured into an ink reservoir 65 is fed to an ink chamber 67 through a tube 66. Pulse voltages are applied to a piezoelectric elemnt 68 in syncronization with the bitmap from the host computer (Fig. 8), and the ink stored in the ink chamber 67 is jetted through nozzle orifice 69 to print the desired pattern on the moving paper.

In Fig. 8, there is shown a connection betwwen a printing unit 71 and a host computer 70. As mentioned above, the patterns to be printed on the paper is transmitted from the host computer 70 to the printing unit 71.

In Fig. 9, there is shown an erasing unit which erases the patterns printed on the paper by ink. When the paper on which ink pattern is to be erased is inserted, a paper feeding mechanism 73 feeds paper 110b first onto an image scanner 74, and then onto a lambda-sita lens 75. The image scanner 74 reads the pattern on the paper to be erased, and the data thus obtained is stored in a storage device 77 by a control circuit 76 before erasing operation. When storage of the data is not necessary, the image scanner 74 and the storage device 77 can be omitted.

After the data are read by the image scanner 74 and stored in the storage device 77, the paper is fed onto the lambda-sita lens 75. At that time, laser beams emitted from an argon laser 78 passes through a condenser lens 79, then reflected right angles by a half-mirror 80, and to a polygon mirror 81. By a motor 82 which rotates the polygon mirror 81, the argon laser beams perpendicularly impinges on the paper

surface for erasing operation. The argon laser beams for erasing operation sweeps the whole surface of the paper to cause the ink attached on the paper to change into its original achromatic condition. The reference numeral 83 indicates a synchronization sensor and the reference numaral 84 indicates a laser power sensor.

In Fig. 10, there is shown a configuration of the erasing unit described with reference to Fig. 9. This erasing unit comprises a paper feeding syetem, a laser scanning optical system and a system control system similar to the printing unit of Fig. 6. The Erasing unit is provided with an image scanner 99 ,which corresponds to that indicated at 74 in Fig. 9, for reading the patterns and a storage device 100, which dcorresponds to that indicated at 77 in Fig. 9, for storing the data thus obtainded.

The paper which has the pattern to be erased is first fed onto the image scanner 99 by a paper feeding mechanism 87, which corresponds to that indicated at 73 in Fig. 9. At that time, the patterns printed on the paper is read by the image scanner 99, and the information data thus obtained is stored in the storage device 100. The output of an erasing argon laser 89, which corresponds to that indicated at 78 in Fig. 9, is always monitored and controlled to obtain a predetermined output level by a laser power sensor 95, which corresponds to that indicated at 84 in Fig. 9. The laser beams are condensed by the condenser lens and perpendicularly impinged on the paper surface by a polygon mirror 91, which correspoonds to that indicated at 81 in Fig. 9 and a lambda-sita lens 92, which corresponds to that indicated at 75 in Fig. 9, to be scanned. This causes the ink to thermally change and reversibly return to achromatic condition.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A paper made from materials interchangeable into non-visible/visible conditions whereby a pattern printed on the paper can be erased to reuse the paper repeatedly.

2. A paper according to claim 1 wherein said materials are selected from a group consisting of a phase changeable material in which its reflective index or reflectance varies in accordance with the amount of heat applied thereto, composite materials of opto-magnetic layer and polarization layer in which polarization plane varies in accordance with the applied external magnetic field, and a photochromic material in which absorbance varies when lights of different wavelenghs are applied.

3. A paper according to claim 1 wherein said materials are applied or mixed, or mixed or applied by microcapsulization, or deposited by sputtering vaporization, to said paper.

4. A system for printing and/or erasing a paper made from materials reversibly interchangeable into non-visible/visible conditions which comprises erasing means for changing the pattern printed on the paper from visible condition to non-visible condition and printing means for changing the pattern printed on the paper from non-visible condition to visible condition.

5. A system according to claim 4 in which said erasing and/printing means comprses a thermal printer and/or a laser printer.

6. A printing system for a paper made from materials reversibly interchangeable into non-visible/visible conditions which comprises a paper feeding mechanism for feeding a paper through a printing position, a laser source for generating

laser beams, and scanning means for scannig the laser beams impinged on the paper fed through the printing position.

7. A printing system according to claim 6 which further comprises a control circuit for on/off controlling the generation of laser beams.

8. An erasing system for a paper made from materials reversibly interchangeable into non-visible/visible condition which comprises a paper feeding mechanism for feeding a paper through an erasing position, a laser source for generating a laser beams, and scanning means for scannig the erasing laser beams impinged on the paper fed through the erasing position.

9. An erasing system according to claim 8 which further comprises recording means for reading and recording patterns printed on the paper prior to the erasing of the patterns.

10. An ink made from materials reversibly interchangeable into non-visible/visible conditions.

11. An ink according to claim 10 wherein said materials are selected from a group consisting of a phase changeable material in which its reflective index or reflectance varies in accordance with the amount of heat applied thereto, composite materials of opto-magnetic layer and polarization layer in which polarization plane varies in accordance with the applied external magnetic field, and a photochromic material in which absorbance varies when lights of different wavelenghs are applied.

12. A system for printing and/or erasing an ink made from materials reversibly interchangeable into non-visible/visible conditions which comprises erasing means for changing the pattern printed on the paper from visible condition to non-

visible condition and printing means for changing the pattern printed on the paper from non-visible condition to visible condition.

13. A system according to claim 12 in which said erasing means comprses a thermal printer and/or a laser printer.

14. A system according to claim 12 in which said printing means comprises an ink jet printing system or an impact printing system which includes an ink ribbon on which ink is applied and an impact printing head for printing said ink applied on the ink ribbon on the paper.

15 A system for printing and/or erasing an ink made from materials reversibly interchangeable into non-visible/visible conditions which cvomprises ink jettting means for jetting an ink to the paper and control means for controlling the jetting of ink in accordance with the patterns to be printed on the paper.

16. An erasing system for an ink made from materials reversibly interchangeable into non-visible/visible condition which comprises a paper feeding mechanism for feeding through an erasing position a paper on which ink is applied to, a laser source for generating laser beams, and scanning means for scannig the erasing laser beams impinged on the paper fed through the erasing position.

17. An erasing system according to claim 8 which further comprises recording means for reading and recording patterns printed on the paper prior to the erasing of the patterns.

FIG. 1

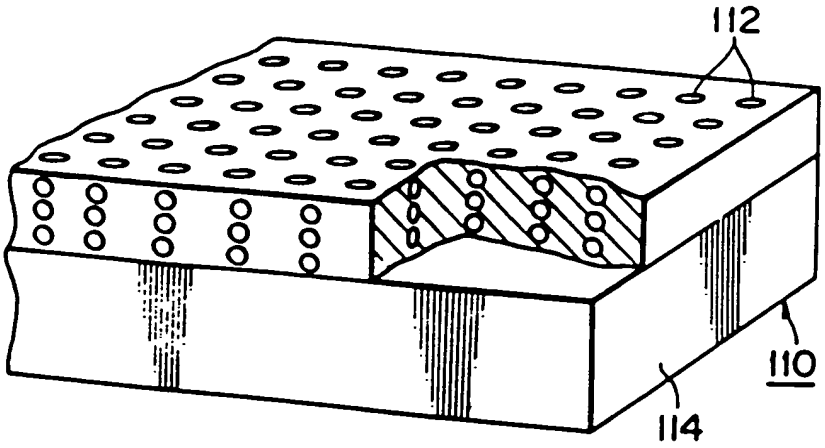
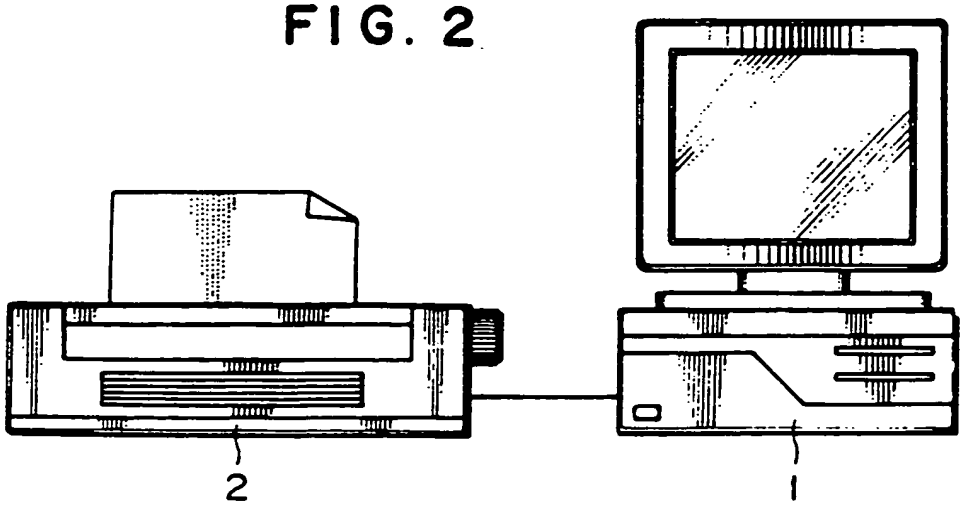


FIG. 2



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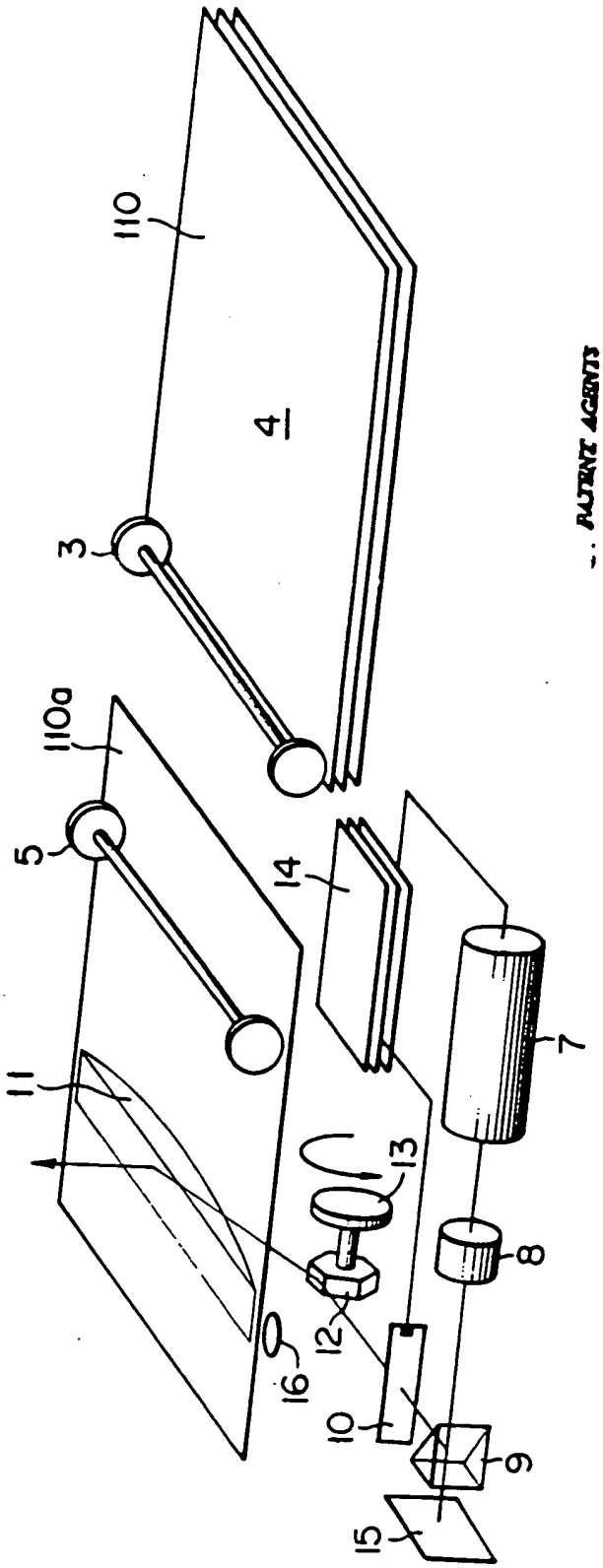
Swabey Ogilvy Renault

FIG. 3



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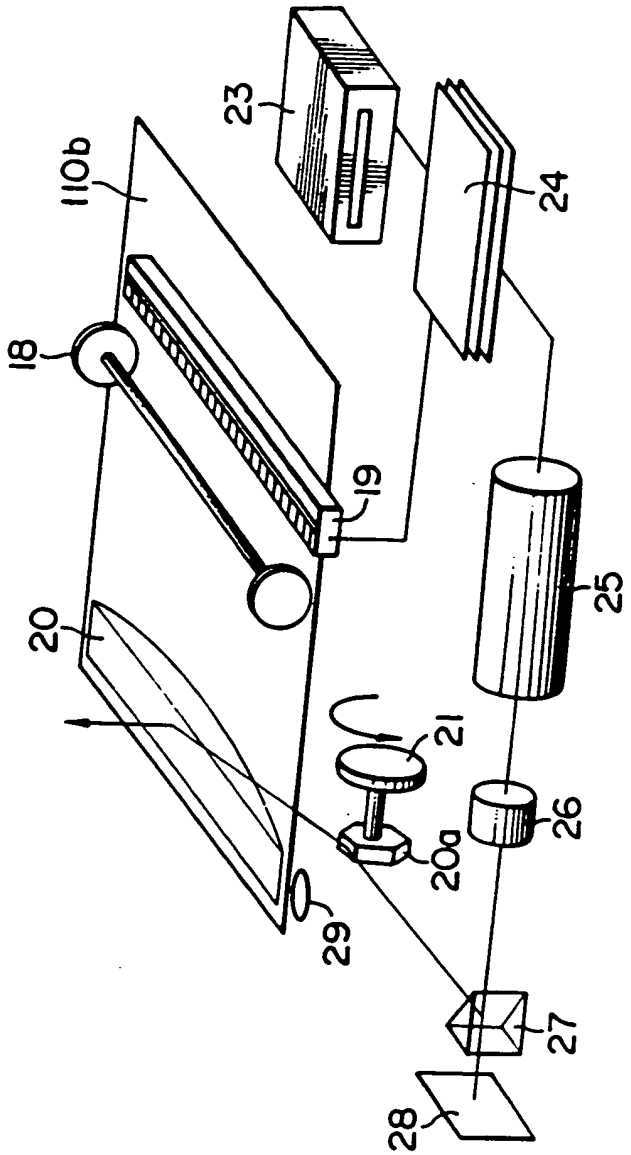
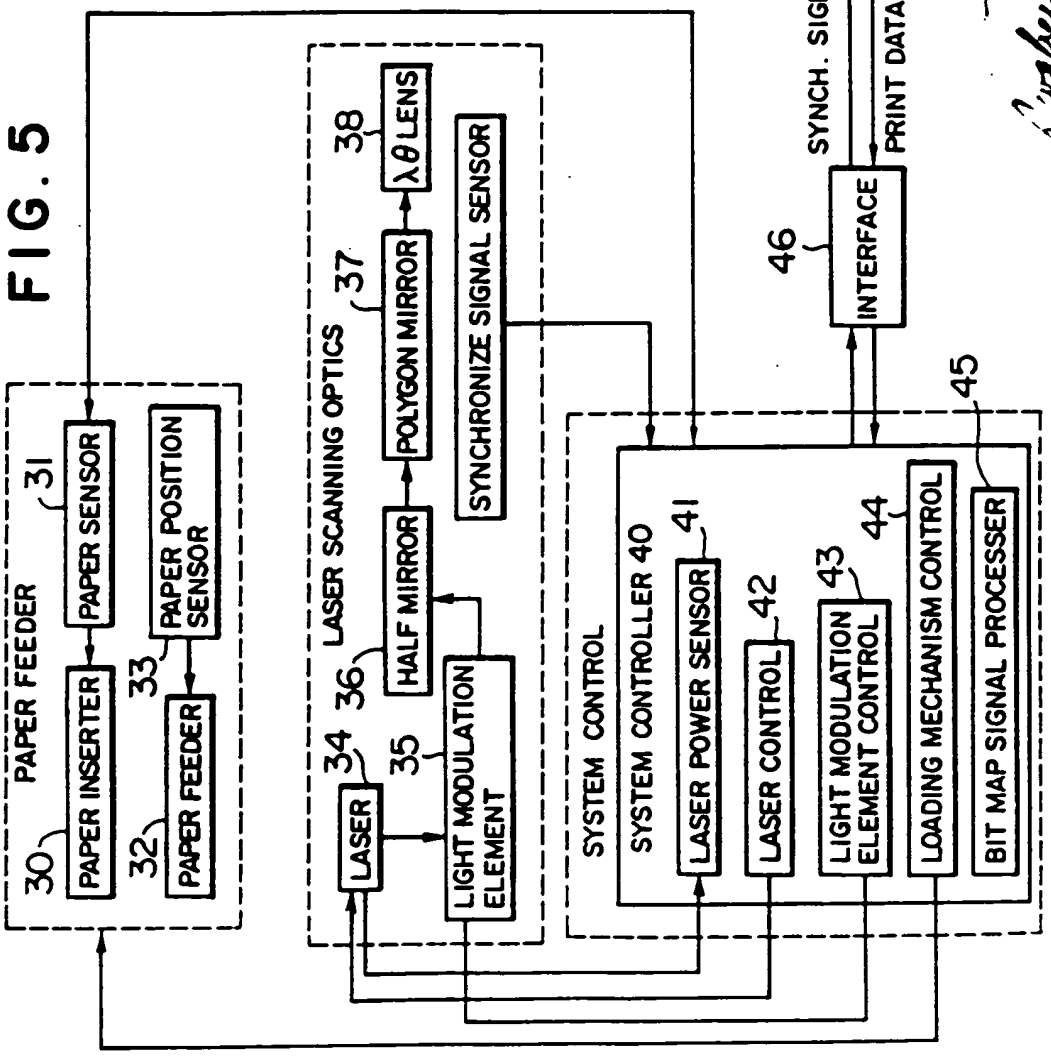
Ruxley Gilby Rivaudeau

FIG. 4



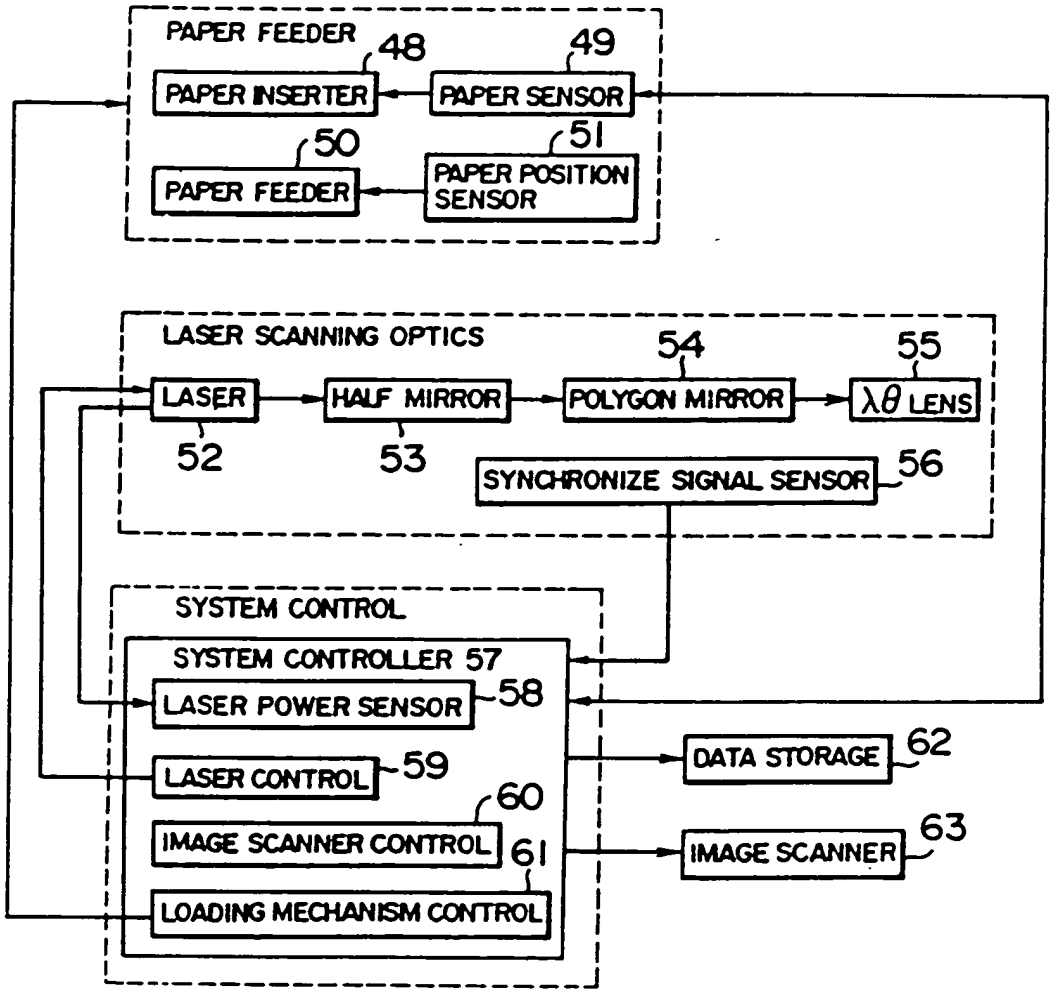
PATENT AGENTS
Rushby Gilby Kenrick

FIG. 5



PATENT AGENTS
Bradley Ogilvy Kennedy

FIG. 6



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Ogilvy Renault

FIG. 7

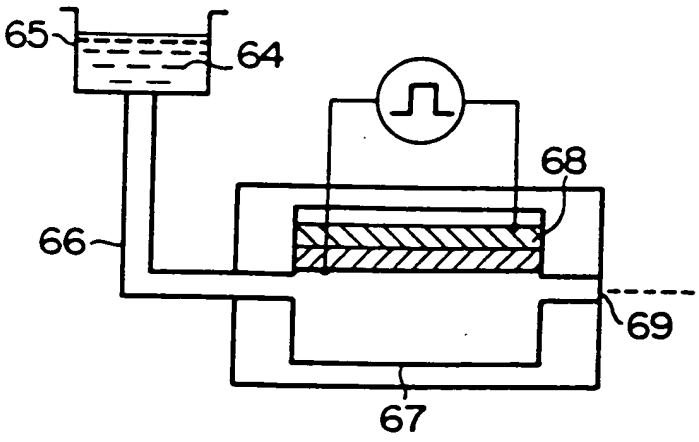

FIG. 8

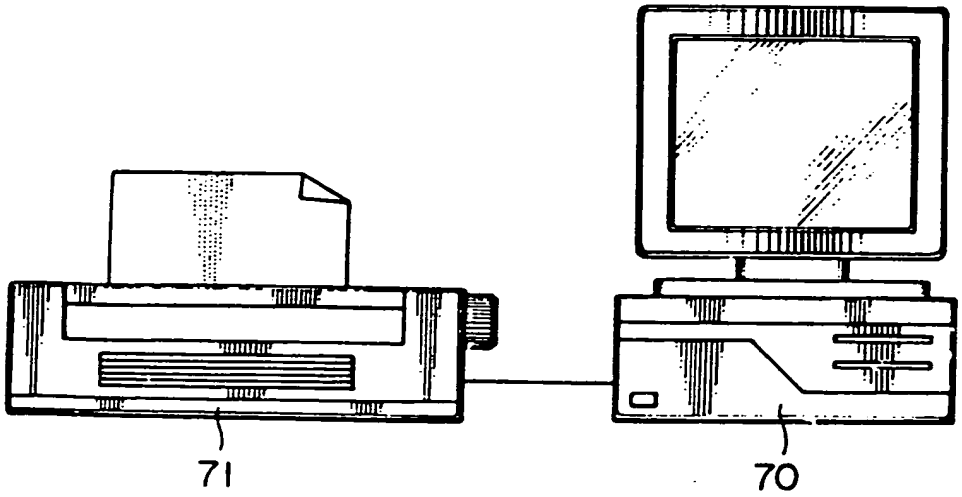

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FIG. 9

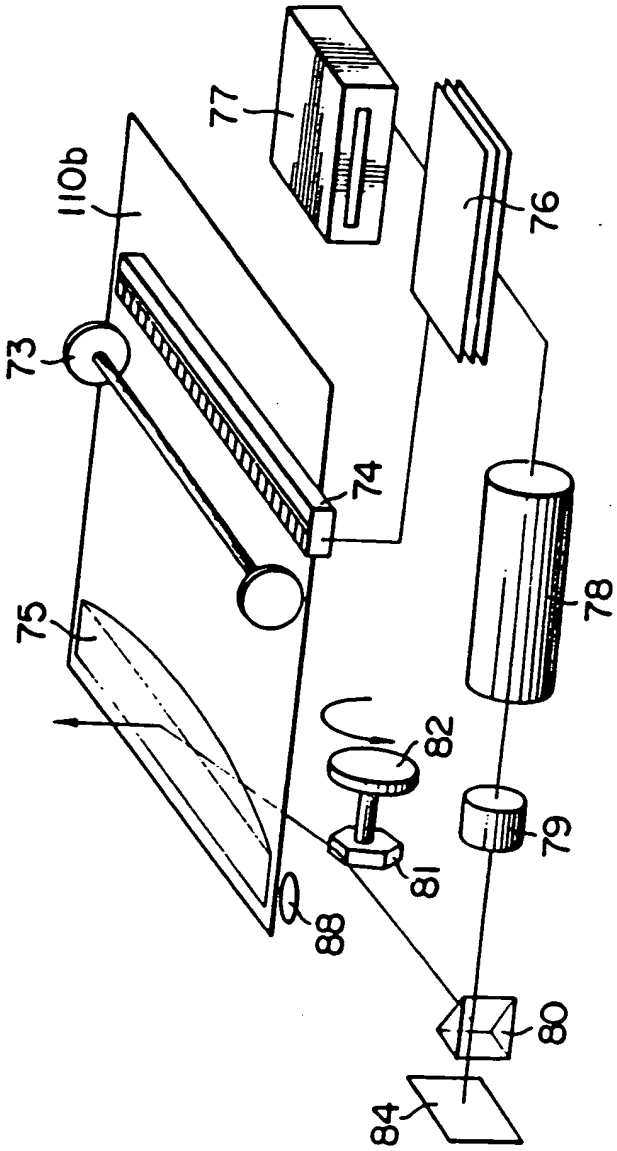
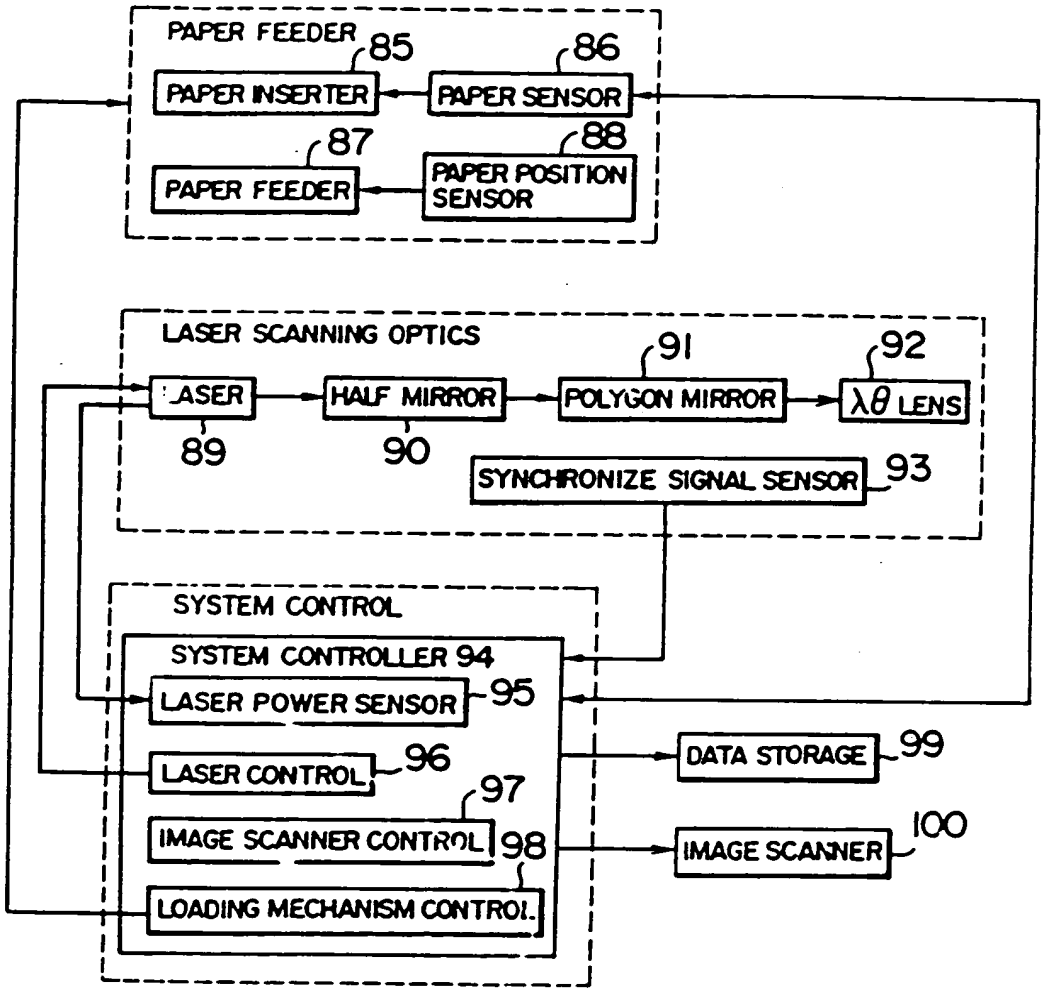


FIG. 10



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